

# High Energy Astrophysics Program

Contract No.  
NAS5-32490



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## Technical Report

for

April 1, 1996 through September 30, 1996



by

Universities Space Research Association  
Mail Code 610.3  
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NASA/Goddard Space Flight Center  
Greenbelt, Maryland 20771



Task Activities under Contract NAS5-32490 during the Period of  
April 1, 1996 through September 30, 1996.  
(individual project reports are attached on the indicated pages listed by task number)

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**University Space Research Association Goddard Visiting Scientist Program**  
**Employee name: Lorella Angelini Task Number: 5030-01A-39**

**Software Development and maintenance**

**XRONOS:** Two versions of the software are currently available one under XANADU and a second under FTOOLS. The two versions will be maintained in parallel until all the XRONOS-XANADU applications will be moved under FTOOLS. In the last semester I have been working towards a distribution of the software compatible with both environments. This involves changes in how the FTOOLS programs are set-up (environment variable) and build (makefile). I have made the following changes in the software: 1) the lcmath task has been upgraded by allowing several error calculations on the results, 2) set-up of an environment variable pick-up by the software for the standard plotting command files directory, 3) the filename decoding routine allows now to import files with +/- character in the filename (convention used by the XTE-ASM), 4) fix various fortran errors and warning due to portability issue across different platform. All these changes were included in the FTOOLS 3.6 release.

A new programmer, James Peachey, started working on XRONOS (end of september) full time. The previous programmer was only part-time on the project, not suitable for the project size.

I am working on a task that will correct data for the binary orbit. I am using this task for the analysis of the newly ASCA data from GX301 pulsar, and it will be part of the XRONOS package.

I have been maintaining the barycenter correction for the ROSAT project, and the new version with the updated leap-second and spacecraft clock correction tables have been delivered to the FTOOLS ROSAT subpackage for the FTOOLS 3.6 release. I made extensive tests of software using the Crab pulsar data taken from different years by ROSAT.

I have been working on a new task that will calculate the galactic  $N_H$  for a given position in the Sky. The task makes use of the HII map obtained by Dickey and Lockman. The map includes the full sky. The task is going to replace the current on-line version of a similar program which uses an HII survey not correct for the galactic center.

**XIMAGE:** I have upgraded the point spread function command for the circle and box geometry. I have also made fixes in the software for reported bugs.

**EXOSAT** I have worked on the production of the second EXOSAT CD containing all the lightcurves, spectra taken with the ME, GS, LE instruments on board EXOSAT in 3 years operations. The CD master copies were made the beginning of May. I have written scripts to generate the gif files for spectra and lightcurve for all the experiments (ME, GS, TGS, CMA1 and CMA2) and wrote the booklet which accompany the CD. I have coordinated the technical (B. Perry) and graphics (K. Smale) part for the final production. Additional tests were required after the CD went in production, because I found a CD reading problem occurring on some platform. The additional testing revealed bugs in the reading CD software of the following operating systems OSF/1 V3.2A (and lower version) and under Window 95.

I have updated the EXOSAT restoration WWW pages.

**Other Restoration Data** I have been monitoring the re-creation of the GINGA LACDUMP FITS files, the HEAO1 A1 data (B. Perry technical support) and the Einstein SSS lightcurves (D. Dawson technical support). The GINGA files were completely re-made adding columns containing count/sec for all the interesting quantities. Gif files were also created. All the data have been transcribed onto CD roms. I designed the FITS format, provided scripts (based on EXOSAT data) for generating the gif files, and checked files

compatibility with the HEASARC software. The Einstein SSS lightcurves were re-generated following the HEASARC lightcurve standard format. I have provided the software to translate from the old rbf formats to FITS and the scripts to generate the associate lightcurve and spectral gif files. I made extensive tests on the validity of the HEAO1 A1 data.

**SAX** I have made available the approved list of SAX proposal which includes both the CORE and the GO time. The database is available under the HEASARC on-line system , W3BROWSE and the xray account.

**FITS Format:** I have been designed FITS file format for the GINGA LAC data, the HEAO1 A1 and A2 experiments and for the SAX PDS experiment (used in direct mode). I gave a presentation at the HEADCC meeting in June about the HEASARC FITS convention.

#### Community Service:

- I reviewed the technical feasibility for proposals, submitted through the "Astrophysical Data Program" (95-ADP-09), which make use of the HEASARC archive.
- I served on the AO2 XTE proposal evaluation Peer Review (26-28 August) as member of a galactic panel.

#### Working Papers and Proposal:

- *The ROSAT variable sky* . Angelini, White Giommi. The sample of variable stars was obtained using the 'timing' imaging technique applied to all the sequence processed for the WGA catalog. After an accurate screening of all sources with a  $\chi^2 > 50$ , a sample consisted in 216 sources was obtained. The spectra and lightcurves characteristics suggest that most of sources are probably flare stars with a characteristics temperature of 1 keV. The sample also included peculiar objects such as AM Hers, Be star systems, soft AGN and QSO. Their spectral characteristics is different from the rest of the sample. These results were presented by N. White in the meeting (17-18 October 1996) for a new possible X-ray mission LOBSTER which will scan the X-ray sky.
- *ASCA Observation of the Big Dipper*. I analyzed the ASCA data of the Big Dipper, to study both spectral and temporal characteristics. Results were presented at the conference *Accretion Phenomena and Related Outflow*, Port Douglas (July 1996).
- Periodicity in the WGA sources. I have analyzed the X-ray data of the newly discovered X-ray pulsar in SMC. This is part of the systematic search for periodicity in the WGA sources in collaboration with G. Israel and L. Stella.
- *X-ray Spectra of LMXRB with Low absorption*. I have analysed a sample of 5 LMXRBs with low absorption. The source spectra reveal low energy line emission in the Oxygen band. This is quite different from the energy line pattern found in others low mass X-ray binaries with higher luminosities, suggesting maybe different evolutionary scenario.
- *XTE and ASCA*. I was Co-I on two XTE proposals (AO2) and PI on one ASCA proposal (AO5). Both the XTE proposals have been accepted, the results for the ASCA proposals are not known yet.

#### Published Paper and IAUs:

- *The X-ray Evidence that the 51 Peg Companion is a Planet*, Pravdo, S.H, Angelini, L., Drake, S. A., Stern, R. A., White, N.E., 1996, accepted May 9, New Astronomy.
- *Archival Observation of the ultra-soft X-ray transient 4U1630-47* Parmar A.N., Williams, O.R, Kuulkers, E., Angelini, L., White, N.E., 1996, Accepted August 5, A&A in press.
- *An ASCA Observation of the X-ray Binary GX301-2* Saraswat, p., Yoshida, A., Mihara, T., Kawai, N., Takeshima, T., Nagase, F., Makishima, K., Tashiro, M., Leahy, D. A., Pravdo, S., Day, C. S. R., and Angelini, L., 1996, Ap. J. 463, 726.
- *Accretion Disk Coronae*, White N. E. , Kallman T. R., Angelini L., in "X-Ray Imaging and Spectroscopy of Cosmic Hot Plasmas", Ed. F. Makino, Tokyo, March 11-14, 1996.
- *The Discovery of 13 s X-ray pulsations from the Hydrogen depleted subdwarf O6 star binary*, Israel G., Stella L., Angelini L., White N., Giommi P., Treves, A., Kallman, T., 1996, Accepted August 11, Ap. J. L., in press.
- ASCA observation of 4U1624-49, Angelini L., Parmar A.N., White N.E., IAU Colloquium No. 163, "Accretion Phenomena and Associated Outflows", Eds. Dayal Wickramasinghe, Lilia Ferrario & Geoff Bicknell, 15-19 July 1996, Port Douglas, Queensland, Australia.
- *The Nature of the "6-s" and related X-ray Pulsars: Evolutionary and Dynamical Considerations*, P. Ghosh , L. Angelini, and N.E. White 1996, Accepted Oct 7, Ap. J., in press.

1996 Apr - 1996 Oct  
M. F. Corcoran (5030-02A-39)

To: Michele Barton  
From: Dr. M. F. Corcoran  
Activity: 5030-02A-39  
Subj: Semi-Annual Technical report, 1 Apr 1996 - 30 Sep 1996  
Date: 30 Oct 1996

PROGRAMMATIC ACTIVITIES ACCOMPLISHED

1) ROSAT Public Data Archive

- a) In this period 975 US ROSAT datasets and 693 German/UK ROSAT data sets were released to the archive. In this period 847 REV0/1 datasets were replaced by reprocessed REV2 datasets.
- d) the ROSAT archive data lists have been updated to reflect recent ingests.
- e) Number of e-mail communications during this period: 655, including user comments, data release and archive maintenance communications.

2) ROSAT Results Archive

- a) I wrote and am testing a prototype archive data browser for the HRI data. This allows the user to access the database of screened, public data, set screening criteria, and plot X-ray sources on optical and X-ray images.
- b) RRA data screening continues. 365 data sets have been screened at the GSFC in this period.
- c) I continue to maintain the RRA Web page at GSFC (<ftp://heasarc.gsfc.nasa.gov/rosat/data/qsrc/www/RRA.html>). This page contains the RRA User Guide, software information and results of dispersion testing at the different screening sites, among other links.
- f) Number of e-mail communications during this period concerning Results Archive matters: 221
- g) the 1st versions of the BROWSE data tables for the PSPC and HRI sources have been compiled and implemented in BROWSE.

3) ROSAT Rationalized Data File development

- a) I helped Maia Good port the RDF software to the ALPHA environment and tracked down some bugs.
- b) at the request of MPE we changed software to allow RDF conversion to be run on proprietary All-Sky Survey data.
- c) Number of e-mails concerning RDF matters: 94

4) RGO/HEASARC duties

- a) The RGO continued its series of bi-weekly meetings
- b) number of e-mail communications regarding RGO issues: approximately 297, including user questions and internal RGO problems.
- c) I produced the 6th volume of ROSAT images on CDROM (with B. Perry and K. Smale). These CDROMS were distributed at the Jun AAS meeting in Madison, WI.
- d) I provided RGO support to Richard Shubert during this period.
- e) I provided technical support at the ROSAT AO7 peer review in 15-17 Jul.



1996 Apr - 1996 Oct  
M. F. Corcoran (5030-02A-39)

#### SCIENCE ACTIVITIES

1) I've taken the lead in organizing a "large project" of X-ray observations of OB and WR stars using ROSAT and ASCA. As part of this effort I was PI on a successful ROSAT AO7 "large project" to look for correlated variability in X-ray and optical emission for young massive stars in the Carina nebula, including Eta Carinae.

2) I worked with Bish Ishibashi, a grad student from UMinn, who's been analyzing my XTE observations of Eta Carinae. Bish will continue to analyze new data as available, and was a Co-I on a successful XTE proposal to continue monitoring Eta Car through 1997. Bish plans to develop the XTE analysis, along with optical spectral analysis under Kris Davidson, into a thesis project.

3) I was Co-author on 2 peer-reviewed papers in this period.

#### TRAVEL

1) I attended the HEAD meeting in May and presented a talk describing the Massive star X-ray observing effort.

2) I attended the AAS meeting in Madison in Jun and presented a talk on X-ray variability caused by wind collisions in massive binaries.

3) I attended the ADASS meeting in Charlottesville and presented a poster on the ROSAT Results Archive.

1996 Apr - 1996 Oct  
M. F. Corcoran (5030-02A-39)

## PAPERS

### PUBLISHED:

"ASCA Observations of Gamma2 Velorum ( WC8+O9I): The Variable X-ray Spectrum of Colliding Winds", I. R. Stevens, M. F. Corcoran, A. J. Willis, A. M. T. Pollock, S. L. Skinner, F. Nagase, and K. Koyama, MNRAS, in press.

### SUBMITTED:

"Dynamic Processes in Be Star Atmospheres. VI. Correlated X-ray, Ultraviolet, and Optical Variations in Lambda Eridani", M. A. Smith, T. Murakami, H. Ezuka, B. G. Anandarao, A. Chakraborty, and M. F. Corcoran, ApJ, submitted.

## PROPOSALS SUBMITTED/AWARDED

I was PI on an accepted XTE AO2 proposal to observe Eta Car (\$14K awarded)

I was PI on an accepted ROSAT AO7 proposal to observe the Carina Nebula (\$16K awarded)

I'm PI on a submitted ASCA AO5 proposal to observe Eta Car with ASCA

1996 Apr - 1996 Oct  
M. F. Corcoran (5030-02A-39)

#### PLANNED ACTIVITIES

- 1) Continue screening of data and population of ROSAT Results Archive and creation/population of source catalogue.
- 2) Continue supervision of ROSAT Public Archive including ingest of WG data and ingest of REV2 data (the final archive product).
- 3) Continue guest observer support activities
- 4) Publish results of Eta Car X-ray campaign; also publish results on X-ray variations from colliding winds in OB binaries.
- 5) Continue monitoring X-ray emission from Eta Car.

## SEMI-ANNUAL TECHNICAL REPORT FROM DR. STEPHEN A. DRAKE

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CODE 660.2/LHEA:HEASARC RESEARCH SCIENTIST

1996 April 01 - September 30

### WORK ACCOMPLISHED AND IN PROGRESS

#### (i) Science Related

##### - Guest Investigator Proposal Status

Of the 3 ROSAT AO-7 proposals of which I was Co-Investigator, 2 proposals PI'd by Ted Simon (U. Hawaii) and S. White (U. Maryland) were awarded observing time.

I submitted 1 XTE AO-2 proposal (to catch an RS CVn system undergoing a superflare) and it was accepted. I submitted a budget for this proposal at the end of September, but have, as of the date of writing, not been notified as to the amount of funds that have been allocated to it.

##### - Scientific Meetings

I attended the High Energy Astrophysics Division of the AAS Meeting held in San Diego, CA April 30 - May 03 1996. I gave a poster paper on the subject of 'Abundance Measurements of Late-Type Stellar Coronae: How Reliable Are They?'. At the beginning of the meeting there was a special ROSAT Workshop on the subject of what the best uses of ROSAT observing time should be in the few years prior to the launch of AXAF. I was asked and gave an oral presentation at this workshop on the subject of 'ROSAT HRI Observations of Stars in the Pre-AXAF Era'. This was published in the ROSAT Newsletter that was published in the summer of 1996.

I attended the American Astronomical Society Meeting held in Madison, WI from June 09 - 13. I gave a poster paper on the subject of 'The Influence of Binarity on the X-Ray Emission Properties of Cool Dwarf Stars: The 100 Pc Sample.' At the beginning of the meeting there was a special session organized by the NRC's Task Group on Space Astronomy and Astrophysics: this group, also known as the Thaddeus Committee, has been tasked by NASA to provide input on what the priorities should be for NASA space science missions in the early part of the next century. I gave a short oral presentation at this session on what requirements are needed for an X-ray observatory in order for it to make significant improvements in our understanding of stellar coronae and flares.

I attended the HTXS Workshop held in Boston, MA from September 30 - October 01 1996, and gave an oral presentation entitled 'High-Resolution, High-Throughput, Broad-Band X-Ray Spectroscopy of Stellar Coronae and Flares: Sample Simulations'.

- Scientific Publications

These were listed in some detail in my recently submitted 'Summary of Accomplishments'. I have attached a copy of my (updated) bibliography for 1996 to the paper copy of this report.

- Refereeing and Proposal Reviewing Duties

At the request of Dr. N. E. White (HEASARC director), on April 12, I evaluated several ADP proposals to use Einstein archival data at the HEASARC in order to estimate the potential impact on HEASARC resources.

In April 1996, I refereed a paper that had been submitted to Astronomy and Astrophysics.

In May 1996, I reviewed a research proposal that had been submitted to the Division of Atmospheric Sciences of NSF. In May to August 1996, I acted as referee for a paper that had been submitted to Astrophysical Journal Letters (ApJL).

In June 1996 and in September 1996, I turned down requests to referee papers that had been submitted to ApJL and Astronomical Journal, respectively (Enough is enough!).

In July 1996, I served as a ROSAT AO-7 Guest Investigator Proposals Review panel member in Tyson's Corner, VA.

- Other Science Activities

I participated in 2 meetings of the joint GSFC/SAO et al. NGXO/LAXSM Concepts Project (now rechristened as HTXS), the first held on April 18, at GFSC, the second held on June 26 at Columbia University, NY. I also submitted a coronal science discussion that was included in the interim report of this group.

I agreed to participate in two other mission studies: Chronos, a UV to X-ray broad-band monitoring concept led by Ron Polidan (GSFC), and LOBSTER, an X-ray all-sky monitoring concept led by W. Friedhorsky (NRL).

I reduced the ASCA spectral data that were obtained in an observation of Alpha Centauri that was made in March 1996, working in collaboration with a large group of Co-Investigators. I also assisted Nancy Brickhouse and Jeremy Drake (both of SAO) to reduce ASCA data that they had obtained of Capella and Lambda And, respectively, in my capacity of Co-Investigator on their projects.

(ii) Programmatic

I continued to monitor the WWW, anonymous ftp and Gopher services provided by the HEASARC to the scientific community. We are presently transferring data via ftp, http, and Gopher utilities at a rate of about 20 Gigabytes per month, while our data archive has reached a size of about 400 Gigabytes. I also continued to monitor the HEASARC's e-mail hotline request@athena. In the period covered by this report, I accumulated 680 messages in my 'request' mail folder, about equally divided between messages to request and our replies. I either answered

these queries/comments myself, ensured that they were answered by the best-qualified HEASARC member, or forwarded them to a more appropriate hotline or expert.

Our database generation procedures were changed due to the need to ensure that new databases be brought up near-simultaneously in both our old BROWSE and new W3BROWSE systems, and also due to the retasking of Pat Tyler. Margo Duesterhaus (HSTX) is now in charge of co-ordinating the HSTX staff members working in this area. The following 14 databases and catalogs were either created or revised in the period covered by this report and installed in both systems:

Name	Description	Observatory	Updated
ASCAPUBLIC	Archival Data	ASCA	96.285
ASCALOG	Observations Log	ASCA	96.212
BD	Bonner Durchmusterung	CATALOG	96.151
SMCSTARS	Probable Members of SMC	CATALOG	96.240
A2SPECTRA	HEAO1 A2 Spectra	HEAO1	96.255
EUV	EUVE Master Catalog	MASTER CATALOG	96.271
ROSSTL	Short-term Timeline	ROSAT	96.213
ROSMATER	Master Log	ROSAT	96.206
RASSBSC	All-Sky Survey Bright Sources	ROSAT	96.173
ROSPUBLIC	Archival Data	ROSAT	96.261
ROSATLOG	Observation Log	ROSAT	96.290
ROSAO	Proposals	ROSAT	96.227
ROSDISTRIB	Distributed Data	ROSAT	96.277
SAXAO	Approved Pointings	SAX	96.220

The TOPBASE atomic physics database has now been installed on a dedicated machine 'topbase'. I have delayed making this a public service on legacy until we receive permission to copy the WWW pages for this service that are presently available at the European Stellar Data Center (CDS) in Strasbourg, France. We are awaiting notification of this from Dr. Carlos Mendoza, the principal maintainer of the TOPBASE database.

#### NON-LOCAL TRAVEL

1. To HEAD Meeting in San Diego, CA from April 29 to May 3 (see above).
2. To AAS Meeting in Madison, WI from June 9 to 13 (see above).
3. To HTXS Team Meeting in New York, NY on June 26.
4. To HTXS Workshop in Boston, MA from September 30 to October 1.

#### WORK PLANNED FOR NEXT SIX MONTHS

I will continue my research into the coronae of stars using hard X-ray, soft X-ray, extreme-ultraviolet, and radio observations as probes of their physical environments.

I will continue overseeing the anonymous ftp account on HEASARC's LEGACY computer, as well as the HEASARC's ADS node, and the request@legacy user hotline. I will continue monitoring our creation of BROWSE and W3BROWSE databases and catalogs.

I will complete the installation of the TOPBASE database of atomic database on our computers and its provision to the external user community via a captive account and/or a WWW interface.

**Semi-annual Technical Report for the Period from April 1996 to September 1996**

**Ken Ebisawa, code 660.2, ASCA GOF**

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**PROJECT WORK**

- # Helped planning ASCA observations of US guest observers.**
- # Answered questions from US ASCA guest observers regarding ASCA data analysis and calibration.**
- # With other members of the ASCA GOF, developed the ASCA GOF home page, which is publicly accessible through WWW.**
- # Made two new ftools for ASCA GIS data analysis, ghkcurve and ldeadtime, in cooperation with ftools programmers.**
- # Worked on the ASCA XRT calibration with Dr. Keith Gendreau.**
- # Prepared for a presentation material to the Senior Review held in August for the ASCA mission program to be evaluated.**
- # Participated in the 'High Throughput X-ray Spectroscopy' meeting on Sep 30 to Oct 1 in Boston, and gave an oral presentation with the title 'Study of X-ray Binaries with HTXS'.**

**SCIENTIFIC RESEARCH**

- # Analyzed ROSAT HRI Crab data taken on March 1995.**
- # Participated in the "X-rays and gamma-rays from accreting black holes", meeting at Koninki, Poland, 10-14 June 1996.**
- # Submitted an XTE AO2 proposal entitled SPECTRAL VARIATIONS OF BLACK HOLE CANDIDATES SLICED WITH HARD-XRAY INTENSITIES, and the proposal was accepted.**
- # Submitted two ASCA AO5 proposals entitled FURTHER SPECTRAL STUDY OF SUPER-SOFT SOURCES and TWO X-RAY PULSARS WITH CONTROVERSIAL ORIGINS**
- # The paper 'ASCA Observations of the Iron Line Structure in Cyg X-1' was published (ApJ, 467, 419-434, 1996).**
- # The paper 'X-ray Spectroscopy of Cen X-3 with ASCA over an Eclipse' was published (PASJ, 48, 425-440, 1996).**



- # Working with Y. Ueda et al. on the ASCA GRO1655-40 data taken in 1994. We are writing up a paper to submit.
- # Working with N. Zhang et al. on the ASCA GRO1655-40 data taken in 1995. The paper was submitted to ApJ.
- # Submitted a conference proceeding for the Super-soft Source workshop at MPE, Garching, Germany for Feb 28 Mar 1, 1996, with the title 'ASCA Observation of the Super-soft Source RXJ 0925.7-4758'.
- # Submitted a conference proceeding for the 'X-ray Imaging and Spectroscopy of Cosmic Hot Plasmas' meeting at Tokyo for March 11-14, 1996, with the title 'ASCA Observations of Binary X-ray Sources'.
- # Worked on the ASCA Cyg X-1 high state data observed in May 1996. We are going to submit the paper to Nature.
- # Started working on XTE Galactic diffuse emission data taken as an AO1 Guest Observer program.

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#### WORK PLAN IN THE NEXT 6 MONTHS

- # Submit the ASCA RXJ0925.7-475 paper.
- # Submit a paper on the ASCA GRS1915+15 and GRO1655-40 observations.
- # Continue to work on the XTE Galactic diffuse emission data.
- # Learn about Astro-E ground calibration system, and start designing the Astro-E standard data analysis system.

## TECHNICAL REPORT FOR APR 1 TO SEP 30, 1996

Eric Gotthelf (USRA Research Scientist)  
Task# 666-024  
Code 660.2, ASCA Guest Observer Facility  
Laboratory for High Energy Astrophysics  
NASA/GSFC

### REFEREED PUBLICATIONS

Gotthelf, E. V., Hamilton, T. T., Helfand, D. J. 1995, "The EINSTEIN Observatory Detection of Faint X-ray Flashes," *Ap J*, 466, 779.

Hamilton, T.T., Gotthelf, E. V., Helfand, D. J. 1995, "The Absence of X-ray flashes from Nearby Galaxies and the Gamma-ray Burst Distance Scale," *Ap J*, 466, 795.

Hwang, U. & Gotthelf, E. V., "X-ray Emission Line Imaging Spectroscopy of Tycho's Supernova Remnant," 1996 *ApJ*, in press.

### CONFERENCE PROCEEDINGS

"Measuring the ASCA X-ray Pointing Accuracy" Gotthelf, E. V., Ishibashi, K. and the ASCA team, 1996, in *"X-Ray Imaging and Spectroscopy of Cosmic Hot Plasmas"*, in press.

"The ASCA SIS Source Catalog" Gotthelf, E. V., White, N. E., 1996, in *"X-Ray Imaging and Spectroscopy of Cosmic Hot Plasmas"*, in press.

"X-ray Spectroscopy of the point source coincident with the SN remnant RCW103," Gotthelf, E. V., Hwang, U., and Petre, R., 1996, in *"High Energy Astrophysics Division Conference"*, BAAS.

"Broadband X-ray Spectral Modeling of the Tycho Supernova Remnant," Hwang, U., Hughes, J. P. and Gotthelf, E. V., 1996, in *"High Energy Astrophysics Division Conference"*, BAAS.

### RESEARCH

- Searching through ROSAT data for confirmation of Einstein IPC X-ray flashes (Collaboration with Dr. D. Helfand, Columbia University and Dr. T. Hamilton, California Institute of Technology).
- Finishing up a paper on the Supernova remnant RCW 103, in collaboration with Drs. R. Petre and U. Hwang, and J. Keohane of the Univ. of Minnesota.
- Analysing ASCA observations of the recently discovered pulsar J1105-6107 in collaboration with Dr. V. Kaspi of Cal Tech.
- Participating in an international collaboration on super soft X-ray sources.

### PROJECT WORK

- Managed the ASCA archive.
- Wrote software to check and maintain the ASCA archive.
- Wrote article for ASCA NEWS: "The ASCA Source Positions Uncertainties".
- Maintained and updated ASCA calibration software.
- Performed various ASCA GOF duties.

- Wrote sections of the NASA Reasearch Anouncement for the ASCA project.
- Participated in the ASCA review as a technical Expert.

#### WORK PLANNED FOR NEXT QUARTER

- Continue current projects.
- Continue calibration software development.
- Make ASCA point source catalogue.

#### HONORS OR AWARDS RECEIVED

NASA Group Achievement Award as part of the ASCA Mission Operation team, May 9, 1996

## 1. ASCA Matters:

We have continued our routine ASCA GOF activities (answering e-mail questions, assisting GOs with their observation planning); we have not had many GOs visiting the GOF over the last 6 months. Non-routine ASCA activities during the period are:

- (1) Patch release of ASCA-related FTOOLS (v3.5.1 and v3.5.2), and preparation and testing for the subsequent full release (v3.6).
- (2) Release of AO-5 NRA, and user support up to the proposal deadline (Aug 6).
- (3) Preparation for the AO-5 proposal review.

In particular, I have been delegated the task of organizing the proposal review (reviewer selection, panel assignment etc.) under the supervision of Dr. Rob Petre. Dr. Petre retains the responsibility but many of the day-to-day tasks were carried out by me.

## 2. Future missions:

- (1) Preparation of software for the ASTRO-E mission: we are currently in software and data format definition phase, although some coding is being done in Japan in preparation for the ground tests. My ASTRO-E activities included a 1-day meeting at MIT with the Japanese XIS team members (who were visiting MIT for hardware related reasons mostly).
- (2) I continue my low-level involvement in the development and community outreach for the HTXS mission concept (merging of two concepts, including GSFC-led NGXO). As part of this, I participated in a community dialog during the Madison AAS meeting, and presented my reasons, as a cataclysmic variable researcher, for wanting an HTXS-like mission.

## 3. Research activities:

I attended two conference during this period: the HEAD (high energy astrophysics division of the AAS) meeting in San Diego in late Apr/early May; and the summer AAS meeting in Madison in early June. At the former, I presented an alternative interpretation of the periodicities in the unusual magnetic CV, RXJ1940-20, using archival ROSAT data. At the latter, I presented some preliminary analysis of the ASCA observations of the intermediate polar BG CMi, obtained less than 2 month previously.

I have submitted a paper on the ASCA observation of the eclipsing dwarf nova, HT Cas, to ApJ in late May; the paper has been accepted in August.

## 4. Public outreach and education:

I have joined OXPOG, the public outreach and education group at LHEA. I have contributed texts to the HEASARC learning center web site, and have answered questions from the public on a rota basis.

## 5. Projection of future activities:

During the early part of the next 6-month period, the ASCA AO-5 proposal review and its aftermath (US-Japanese merging meeting in particular) will take up a large fraction of my time. I hope to be able to find time to work on more data analysis and submit one or two journal papers.

## SEMI-ANNUAL REPORT (for the six months ending 30 September 1996)

Employee name: Dr Charles Day      Activity: 5030-04A-39

### PROGRAMMATIC ACTIVITIES:

1. Completed the XTE Getting Started Guide and continued working on The ABC of XTE. Both are currently available on the web, at, respectively:

[heasarc.gsfc.nasa.gov/docs/xte/abc/front\\_page.html](http://heasarc.gsfc.nasa.gov/docs/xte/abc/front_page.html)  
[heasarc.gsfc.nasa.gov/docs/xte/start\\_guide.html](http://heasarc.gsfc.nasa.gov/docs/xte/start_guide.html)

2. Continued maintaining and adding to the RXTE GOF web area which now contains 36 Mbytes of information in 200 files. The home page, at:

[heasarc.gsfc.nasa.gov/docs/xte/xte\\_1st.html](http://heasarc.gsfc.nasa.gov/docs/xte/xte_1st.html),

was visited a total of 6,019 times during June and July this year (for comparison, the ASCA and ROSAT home pages were visited 3,014 and 1,421 times in the same pe-riod, respectively).

3. Like my GOF colleagues, I have been very active helping our GO community. I have spent a total of 91 hours sitting beside and helping the following visiting GOs:

Dr David Smith (University of Maryland)  
Dr Iosif Lapidus (Cambridge University)  
Dr Julian Osborne (University of Leicester)  
Dr Michael Corcoran (GSFC) and Mr Kazunori Ishibashi (University of Minnesota)  
Dr Glenn Allen (GSFC)

4. Provided technical support to the RXTE AO-2 review August 26-28.

### RESEARCH ACTIVITIES

In the past year I have worked on only one research project: the analysis of RXTE spectral data from the X-ray burster X 1728-34. Preliminary findings, pre-sented at the Summer AAS meeting in Madison, WI, hold out the exciting possi-bility of constraining the mass-radius relationship of the neutron star more tightly than ever before. My collaborator Frank Haberl and I have analyzed one burst so far and are in the middle of working through several more.

### PAPER PRESENTED AT SCIENTIFIC MEETING:

June 1996, AAS Meeting in Madison, WI: "RXTE Observations of Spectra Variability in Bursts from 4U 1728-34," C. S. R. Day, T. E. Strohmayer, W. W. Zhang, A. P. Smale, (USRA & LHEA), J. H. Swank (LHEA), L. G. Titarchuk (George Mason U. & LHEA), U. Lee (Tohoku U.)

## **AWARDS:**

May 9th, 1996: Goddard Space Flight Center Group Achievement Award as a member of the ASCA Mission Operations Team.

May 9th, 1996: Goddard Space Flight Center Group Achievement Award as a member of the XTE Science Operations Center.

## **COMMUNITY OUTREACH ACTIVITIES:**

As a member of the OGIP/X-ray Public Outreach Group (OXPOG), I have contributed text to the HEASARC Learning Center.

## **EXTRA-GODDARD COLLABORATIVE ACTIVITIES:**

With Drs. Frank Haberl (Max-Planck-Institut fuer extraterrestrische Physik) and Lev Titarchuk (GSFC & George Mason University), I have been working on analyzing bursts from X1728-34.

With Dr Steve Pravdo, I have been working on analyzing ASCA data from GX 301-2.

## **PAPERS IN REFEREED JOURNALS**

Choi, C. S., Dotani, T., Day, C. S. R., Nagase, F., 1996. "Pulse Phase-Dependent Spectroscopic Study of Vela X-1," *Astrophys. J.*, in press.

Strohmayer, T.E., Zhang, W., Swank, J.H., Smale, A., Titarchuk, L., Day, C. & Lee, U. "Millisecond X-ray Variability from an Accreting Neutron Star System," *Astrophysical Journal Letters*, in press.

USRA REPORT 4/1/96 - 9/30/96

Dr A.B.Giles

Activity: 93-05-00

During the above period Dr Giles continued as the Software Manager for the PCA experiment software development. This period can be characterised by two main themes:

- 1) The continuing in orbit support for RXTE
- 2) The analysis of scientific data from RXTE and its presentation at conferences and/or in publications

**Meetings:-**

Dr Giles attended the following list of meetings at GSFC in connection with the PCA experiment:

PCA rep. at regular SOF meetings	Occasional
PCA rep. at SOF CCB meetings	Every 2nd Thursday
PCA full team group meeting	Every Tuesday
RXTE Users Group Meeting at GSFC	2-3 April
RXTE Users Group Meeting at GSFC	10-11 Sept

**Conferences:-**

AAS HEAD Meeting at San Diego	30 April - 3 May
COSPAR at Birmingham, UK	15 - 18 July
ADASS Conference at Charlottesville	22 - 25 Sept

**Travel:-**

To the 3 conferences listed above. Also a short visit to Leicester University (UK) on 19 July.

**Activities:-**

There were no activities outside the overwhelming constraints imposed by RXTE. As Software Manager Dr Giles continued to coordinate the work of the following programmers:

Hwa-ja Rhee	Hughes STX	PCA Science Monitoring
Vikram Savkoor	Hughes STX	PCA Commanding, Health & Safety

Vikram Savkoor left the team in April and Hwa-ja Rhee in September. Some programming support is now available on a "pool" basis from the regular SOF programmer team. Dr Giles continues to interact with the SOF on behalf of the PCA team for all his previous functions.

A main activity during the period was a substantial change to the commanding strategy for the PCA HV operations. This involved much liaison with the SOF and MOC. All these changes represented a considerable amount of time and effort.

- 1) Many initial changes and experiments were needed to characterise the PCA HV breakdown problems in PCU's 4 & 5.
- 2) New DAP Macros and STOL were developed for a new HV operational strategy (HV completely OFF through the SAA)



- 3) New RTS's for the onboard EDS/TSM setup to automatically turn off a failing detector as soon as an anomaly occurred.
- 4) A further set of refinements to avoid using HV relay on/off commands

#### XTE Observations:-

The following RXTE AO1 observations were made:

24 June - 25 July	PSR1259	(CoI Giles)
18-19 July	GX1+4	(PI Giles)
17 April	GRS1915-105	(PI Giles)
12 May	GROJ1655-40	(PI Giles)

The RXTE AO2 proposal period closed on 27 August and in the subsequent selection process Dr Giles was awarded time for the following observations:

- a) Very High Time Resolution Studies of Cyg x-1 in the High State at Maximum Telemetry Rate (PI Giles)
- b) Generic Observation of all Bright Transient TOO's with very High Resolution and High Telemetry Rate (PI Giles)
- c) The Atoll Bursters 4U1702-429 and 4U1735-44 (CoI Giles, PI Swank)
- d) Continued Monitoring of the emission from GROJ1744-28 (CoI Giles, PI Stark)
- e) Post Glitch X-ray monitoring of the Vela Pulsar (CoI Giles, PI Strohmayer)
- f) A search for the Pulsar in SN1987A (CoI Giles, PI Marshall)
- h) Temporal and Spectral Evolution Studies of KHz X-ray variability in 4U1728-34 (CoI Giles, PI Strohmayer)

#### Documents:-

Many minor revisions to all the PCA documents were made.

#### Publication Activities:-

##### Refereed Publications:

An Efficient Algorithm for the Detection of Infrequent Rapid Bursts in Time Series Data. Giles A.B, 1997, ApJ, 474, in press

The Main Characteristics of GROJ1744-28 observed by the Proportional Counter Array Experiment on the ROSSI X-ray Timing Explorer, Giles A.B, Swank J.H, Jahoda K, Zhang W, Strohmayer T, Stark M.J, and Morgan E.H, 1996, ApJ, 469, L25

GROJ1744-28 - Source down to ~10% of Initial Intensity and still Declining, Giles A.B, 1996, IAU Circular 6385

GROJ1744-28 - RXTE/PCA Observations of the Source Decline, Giles A.B, and Strohmayer T, 1995, IAU Circular 6338

PCA Observations of Cyg X-1 from RXTE using Fast Timing and High Telemetry Rates, Giles A.B, Jahoda K, and Strohmayer T, 1997, COSPAR proceedings, Advances In Space Research, submitted

Real Time Science Displays for the PCA Experiment on the ROSSI X-ray Timing Explorer, Giles A.B, 1997, COSPAR Proceedings, Advances In Space Research, submitted

#### Other Publications:

The ROSSI X-ray Timing Explorer - Taking the Pulse of the universe. Giles A.B. and Nally J. 1996, Sky & Space, Australia, submitted.

In Orbit Performance and calibration of the ROSSI X-ray Timing Explorer (RXTE) Proportional Counter Array (PCA), Jahoda K, Swank J.H, Giles A.B, Stark M.J, Strohmayer T, Zhang W, and Morgan E.H, 1996, SPIE Conference Proceedings, July, Denver, Colorado, 2808, in press.

South Atlantic Anomaly Entry and Exit as measured by the X-ray Timing Explorer, Smith E, Stark M.J, Giles A.B, Antunes A, and Gawne B, 1996, NASA GSFC Flight Mechanics/Estimation Theory Symposium, NASA Conference Publication 3333, p 249

#### Conference Posters:

Real Time Science Displays for the PCA Experiment on the ROSSI X-ray Timing Explorer, Giles A.B, 1996, HEAD AAS Meeting, San Diego, California, April 30 - May 3

Real Time Science Displays for the PCA Experiment on the ROSSI X-ray Timing Explorer, Giles A.B, 1996, COSPAR Meeting, Birmingham, UK, July 14-21

PCA Observations of Cyg X-1 from RXTE using the Fast Timing and High Telemetry Rates, Giles A.B, Jahoda K, and Strohmayer T, 1996, COSPAR Meeting Birmingham, UK July 14-21.

Real Time Science Displays for the PCA Experiment on the ROSSI X-ray Timing Explorer, Giles A.B, 1996, ADASS Meeting, Charlottesville, Virginia, Sept 22-25

#### Next 1/2 year:-

I will be returning to Australia at the end of the year so will only be at GSFC for half this period. I will be attempting to complete as much data analysis as I can while avoiding commitments that extend into 1997. I hope to continue some association with the RXTE project from Australia as an honorary Research associate at the University of Tasmania. The amount of time and effort available for this effort remains unknown.

This report summarizes the activities of Tod Strohmayer over the period April 1, 1996 to September 30, 1996.

#### Calibration activities:

Refinements to the calibration of the PCA detectors on RXTE are continuing. In studying the response of the PCA collimators our initial calibration gave an energy independent description of the collimator efficiency. In order to test the accuracy of this model several other aspects of the calibration need to be well understood. For example, uncertainty in the background as well as the detector deadtime effect our ability to test the collimator model against detailed observations of the crab nebula. Recent successes of the background and deadtime models now enable the collimator model to be tested to about the 1 percent level. This work began in the above period and is continuing.

Initially I have examined the energy dependence of the scan profiles produced by scanning the detectors across the crab nebula. Initial results indicate that any energy dependent effects are less than about 5%, but there is some evidence that the collimators allow more low energy photons through to the detector than the highest energy photons. This effect is understood in that low energy X-rays are more likely to undergo small incidence angle reflections than high energy X-rays; therefore slightly more Low energy X-rays get reflected into the detector. Analysis to date indicates that this effect is no bigger than about 5% between the lowest and highest energy X-rays which the detectors are sensitive to and will be calibrated in the coming months. Additionally, the robustness of the current collimator model is being examined by first calculating background subtracted and deadtime corrected scan profiles using the new background and deadtime models. These efforts will continue in the next few months as well.

I have also contributed to the effort to characterize the absolute timing accuracy of XTE data. This work included studies of the accuracy with which the period of the crab pulsar can be deduced by epoch folding the data.

#### Research activities:

Analysis of RXTE observations conducted since February, 1996 has been ongoing for the entire period which concerns this report. A number of exciting results have been reported in the literature and at several meetings. The following are a few highlights.

- 1) My PI proposal observations of the X-ray binary and burst source 4U 1728-34 revealed new millisecond X-ray variability phenomena. These results have been published (ApJ, 1996, 469, L9 and IAU Circulars 6320, 6387) and reported on at the 1996 High Energy Astrophysics Division (HEAD) meeting of the American Astronomical Society (AAS), 4/30/96 - 5/4/96, and the 31st Scientific Assembly of COSPAR, July 14 - 21, 1996 in Birmingham, England.
- 2) My observations of the pulsar 4U 1907+09 are being analysed with colleagues Jean in 't Zand and Altan Baykal. We have detected unusual cessations in the pulsar emission from the object which have not been characterized previously. The results will appear in a forthcoming Astrophysical Journal Letters.

- 3) Dr. Umin Lee of Tohoku University, Sendai, Japan visited from Sept 3 through 27th. We conducted analysis of RXTE data from the bursting pulsar GRO J1744-28 as well as several X-ray bursts from the Galactic center region. We recently published an IAUC circular (6484) describing a 589 Hz oscillation from a burster in the Galactic center region which resulted from the work conducted during Dr. Lee's visit. A paper describing these results is in preparation.
- 4) I have been involved in a number of results concerning the "bursting pulsar" GRO J1744-28 which have been reported. These include several IAU circulars (6309, 6338, 6414) and two papers describing the results of PCA observations of this source (ApJ, 1996, 469, L68, L76)
- 5) I submitted two proposals for cycle 2 (AO2) observations with RXTE, both proposals were accepted. One concerns followup observations of the kilohertz QPO source 4U1728-34, and the other a post-glitch monitoring campaign on the VELA pulsar. I am a co-investigator on a number of other accepted AO2 RXTE proposals.

November 11, 1996

Semi-Annual Technical Report  
April 1996 - October 1996

**ACE (Advanced Composition Experiment):** ACE is an Explorer that is planned for launch in 1997 to study the solar wind, and heliospheric and low energy galactic cosmic rays. I am assistant to the Project Scientist (Jon Ormes). This requires spending a considerable amount of time in meetings and facilitating communication between the project management here at Goddard, the spacecraft contractor (JHU/APL), and the experiment teams. As we approach the start of spacecraft integration (January 1997) I've been spending more time on ACE (approximately 65%), and this will continue. I am a member of the ACE Mission Operations Working Group, the Spacecraft Operations Working Group, and the Initial Operations Working Group. I attend the weekly Code 410 ACE Staff meeting, the bi-weekly spacecraft status meetings, and science team meetings as scheduled. I am writing a periodic "What's New on ACE" newsletter for the science team and am the author and curator for about 40 pages on the World Wide Web for the ACE spacecraft (<http://www.gsfc.nasa.gov/ace/ace.html>). I also am on the science team for two of the ACE instruments (the Cosmic Ray Isotope Spectrometer and the Solar Isotope Spectrometer) and have been helping with the integration and environmental testing for these instruments. During this time period, I worked on the environmental testing for both CRIS and SIS and am assisting the APL spacecraft team with the integration and test of all the instruments.

**IMAX (Isotope Matter-Antimatter eXperiment):** IMAX is a balloon experiment which we are working on with Caltech, U. of Siegen, and NMSU to measure the fluxes of anti-protons, and hydrogen and helium isotopes over a wide energy range. Our first paper "Measurement of 0.25 - 3.2 GeV Antiprotons in the Cosmic Radiation" by Mitchell et al. has been published in Physical Review Letters Vol. 76, page 3057. We are working on our next papers on the helium isotope ratios and the galactic cosmic ray hydrogen and helium energy spectra.

**ISOMAX (ISOTOpe MAGnet eXperiment):** This is another magnetic spectrometer balloon experiment in collaboration with Caltech and U. of Siegen. It is specifically designed to look at the isotopic composition of beryllium, because  $^{10}\text{Be}$  is a very important clock that can measure the lifetime of all cosmic rays. I am responsible for the onboard command and data handling (C&DH) system and the computer ground support equipment (GSE). The hardware is working, and functional C&DH and GSE software systems are up and running, but both systems are in the process of being expanded.

**TIGER (Trans-Iron Galactic Element Recorder):** TIGER is a balloon borne experiment designed to look at ultra-heavy galactic cosmic rays. It is a collaboration with Washington U. (St. Louis) and U. of Minnesota. During this time period we tried again to fly TIGER, but had another balloon failure (two in a row). We are making some improvements and working towards flying it again this summer. I am Goddard instrument manager for TIGER (meaning I am taking the lead for the Goddard part of the instrument). We are also proposing a combination of our instrument with two high energy instruments for a future space station experiment.

ALICE (A Large Isotopic Composition Experiment): The final ALICE paper is now accepted in Astronomy and Astrophysics!! But it's still not quite published. This should be the last we hear of ALICE except for getting the final citation.

Voyager Cosmic Ray System: I continue to work with Drs. Ed Stone and Alan Cummings of Caltech on a paper for the Astrophysical Journal. I gave a solicited talk at COSPAR in England this summer on my work on anomalous cosmic ray hydrogen.

I also presented a paper (Cooper, Christian, and Johnson) at COSPAR on the darkening of comets in the Kuiper belts by anomalous and galactic cosmic rays. I'll be continuing to work on this topic with my two co-authors.

On top of all this, I continue to be system manager for two UNIX computers.

TO: David Holdridge/610.3, USRA  
FR: Scott Barthelmy/661  
RE: May 1996 through Oct. 1996 Report

01 Nov. 1996

**GRIS project activities:**

After the Fall 95 campaign, I did the post-flight generation of the histograms. These are the "data cleaned", gain-corrected, final histograms that are used by all members of the group for whatever analyses (about 3 weeks of effort). Even after a lengthy investigation into a digital electronics problem that garbled some of the events and their elimination, the mystery 511 keV emission from the gal\_latitude=240 region of the galactic plane still remains. The preliminary stage of my analysis for the cosmic diffuse background spectrum measurement was presented at the "Second INTEGRAL Workshop" in St. Malo, France in September. At this stage only an upper limit, which is about 2-5 times the theoretical prediction, was presented. There is little hope that further, more involved analysis will be able to push this upper limit down by more than a factor of two. In addition to the analysis of the flight data, I carried out laboratory calibration runs (45 days of accumulation) to make a detailed measurement of the off-diagonal energy response. This also involved the oversight of the reassembly and check-out of the instrument after returning from the field. GRIS is being left in a flight-ready configuration in case there is a near-by Type I Supernova.

**PORTIA project activities:**

After the Fall 95 campaign where the PORTIA instrument was flown on two of the three flights in that campaign, I did the post-flight generation of the histograms (about 1 week of effort). These are the "data cleaned", final histograms that are used by all members of the group for whatever analyses.

**BACODINE project activities:**

The BACODINE project continues grow. The Bradford University automated telescope switched to automated operations and the Effelsberg (radio), SAX (gamma-ray s/c), CANGAROO (TeV), and D.Frail (radio follow-up on the SGR) were added to the list of sites.

I was successful with my GRO Cycle 6 Guest Investigator proposal.

I attended the GROCSE team meeting at LLNL in October. Because of GROCSE's superiority over the other optical instruments in the BACODINE network, I have always given special attention to this project and operate at a much higher level of collaboration. I discussed the BACODINE status and future. We discussed the LOTIS instrument (the second generation to GROCSE) and made a preliminary outline for the Ap.J. final paper on the GROCSE results. This paper should be submitted in a Dec. or Jan 97.

I created a web page for the BACODINE project. Its contents is structured mostly for use by the various BACODINE sites, but there is also some basic GRB and astrophysics educational material in there for the general public.

BACODINE continues to occupy about 50% of my time.

#### **InFOCuS project activities:**

We were successful in our new-start SR&T proposal for the InFOCuS balloon project (J. Tueller is PI). I did an initial total-system design of the instrument. A micro-processor architecture and an operating system were chosen and procurements issued. I supervised the mech.eng. for the gondola truss design and procurements for a test of the carbon-fiber truss design were issued.

#### **POLAR project activities:**

I joined the GRB polarimeter team (T. Cline is PI & it is an instrument to measure the polarization component of GRBs). I supervised a summer student (Ben Mazin from Yale as part of the NASA Academy program). We modified the well-known GEANT program to handle the polarization dependence of Compton scattering of gamma-ray photons and simulated the response for four different instrument designs. A preliminary final design was chosen and I issued procurements for 30K\$ of scintillator to make an initial test instrument.

#### **GTOTE project activities:**

This project has been in a period of minimal activity. It should become operational in the next couple months. Routine operations are expected some time this winter. A second system (GTOTE2) is being built and will be installed next Spring at the MILAGRO site in New Mexico.

#### **GRB Follow-up Proposals:**

The KPNO WIYN telescope (I am Co-I) GRB follow-up proposal was accepted. We await the launch of the HETE spacecraft to provide the small error boxes that are needed to match the WIYN FOV.

#### **Other Proposals:**

While my XTE-as-GRB-detector piggy-back program has languished because of the difficulty of autonomously locating "transients" in the detector rates (because XTE is usually observing sources with lots of transient behavior), I was pleasantly re-motivated to continue this effort because XTE recorded the GRB on 96/09/24. This was a high fluence GRB and was recorded by XTE at the >50 sigma level. This now proves my concept that XTE can be turned into a nearly isotropic GRB detector instrument.

Our group is currently redesigning BASIS for the SMEX program. We will submit it Jan 97. I am responsible for the stellar aspect camera (a 1 arcsec absolute system which is well beyond current star tracker systems) and the mounting design and vibration & thermal testing of the CZT detectors.



During the past 6 months, I have been primarily involved in development of the BASIS instrument, and in analysis of the data from TGRS and BATSE.

## BASIS

BASIS is a new instrument concept which we will be proposing as a SMEX this Winter. It uses room-temperature Cadmium Zinc Telluride (CZT) strip detectors with 100 micron spatial resolution and good energy resolution, combined with a coded aperture mask, to locate GRBs to within a few arc-seconds, allowing deep and rapid follow-up observations. Most GRB specialists believe that finding a counterpart for a GRB via a deep and/or rapid follow-up observation is the technique most likely to solve the GRB mystery.

My work has been concentrated in two areas: developing the mask and developing the detectors.

As currently planned, the mask will consist of a 100 micron feature size pattern of 100 micron thick gold on a beryllium substrate. (Gold blocks the X-rays and gamma-rays, beryllium lets it through, so an astrophysical source casts a shadow of the gold pattern on the detector.)

The best way to make this pattern is X-ray lithography followed by gold plating. (Optical and UV lithography does not work for layers of resist more than a few tens of microns thick, due to internal scattering.) I am working with people at the Advanced Photon Source synchrotron at Argonne to develop the processes required to build the mask.

My role in detector development has been to develop the analysis tools for understanding the behavior of the detectors. I am currently working on a prototype system which will produce images using an array of detectors and a coded aperture with the same resolution as the proposed instrument.

Some of this work is also applicable to the InFOCuS balloon instrument which our group is producing.

## TGRS

TGRS, the Transient Gamma Ray Spectrometer, is a high-resolution gamma-ray spectrometer designed with a primary mission to look for features in gamma-ray burst (GRB) spectra. Discovery of these features would provide strong evidence of a Galactic origin of GRBs (or, at least, that particular GRB).

In addition to the normal analysis of TGRS data, I am developing software to look for new kinds of transient gamma-ray phenomena. Most detected GRBs show variability over timescales of a few seconds or less. Slower variations are indistinguishable from the large variations produced by changing particle backgrounds encountered by instruments in Low Earth Orbit, where the background varies by as much as a factor of two during each 90 minute orbital period. TGRS, on the other hand, spends much of its time in interplanetary space, outside of Earth's magnetosphere, and is thus well-placed to notice transient sources that rise slowly over time periods of minutes, hours, or days. In addition, there is a type of transient, seen only once, which has a pure line spectrum. TGRS's high resolution is useful for observing this type of transient.

I have presented a poster paper at a conference (the San Diego HEAD meeting) with preliminary results of this analysis, showing that no events similar to an event known as the 'Jacobson Transient' were seen during a 3-month period.

I am developing techniques (Principal Component Analysis) to characterize the small variations that remain in the background to provide greater sensitivity over a larger range of potential source parameters.

## **BATSE**

I continue to search the BATSE data for spectral lines in GRBs as they occur. So far, no lines have been found.

**Report on work performed at NASA/GSFC under the USRA/GVSP**  
**Period: 01 April, 1996 through 30 September, 1996**  
**Name: Dr. Joseph A. Esposito**

**Tasks**

- a) Writing and upgrading of the Maximum Likelihood Point Source Analysis Software (LAS) to meet new triggering criteria. This included "vertical event mode" and "fan (or strip) mode" for which the EGRET trigger field of view is reduced to diminish the number of events which trigger the spark chambers thus increasing the 'life' of the EGRET instrument. The software package is up to date with minimal (cosmetic) problems. The likelihood Version 5.50 software has been delivered to MPE, LSW and Stanford. Version 5.51 is under development and will be released shortly.
- b) Responding to user questions and problems using the software, responding to software "bugs" reported by users and, if a "bug" exists, rewriting the software to repair the error. All reported "bugs" have been repaired whenever required (most "bug" reports are actually misuse or misunderstanding of the software by a user requiring, in some instances, exhaustive searches for coding errors which do not exist).
- c) Developing, writing and maintaining the *Likelihood Analysis Software Users Guide* which includes a detailed list of all current available functions, file descriptions, environment variables used by the Likelihood Analysis Software. Development of the *Likelihood Analysis Software Users Guide* is on-going work and is also available, in part, on the World Wide Web at URL: <http://lhea-www.gsfc.nasa.gov/~jae/like/>. The WWW LAS Users Guide is on-going work. The package of static HTML files are under development and several dynamic files are being considered. An alphabetically grouped linked HTML list of LAS commands through command "LC" is complete (see the LAS WWW pages).
- d) Laboratory work on the development of Gas MicroStructure Detectors (GMSD). This work replaces the SR&T program development on the AGATE instrument. The laboratory work accounts for 30% of my time at GSFC and includes: detector and circuitry design and, detector testing and calibration.
- e) Analysis of EGRET flight data for use in determining gamma-ray emission from supernova remnants and ultraluminous infrared galaxies (CGRO proposal support) and for inflight calibration of the EGRET instrument (see papers in preparation)

**Proposals**

Awarded cycle 6 EGRET team proposal (GRO-96-242) "Galactic Supernova Target of Opportunity and Data Rights to EGRET Gamma-Ray Observations of Galactic Supernova Remnants".

Awarded SR&T proposal as Co-Investigator (NRA 95-OSS-07) "Development of Gas Microstructure Detectors for Gamma-Ray Telescopes".

Submitted response to ASCA AO (ASCA AO-5) "X-ray Emission from Type II Supernova Remnants (MSH 11-61a and G312.4-0.4) Positionally Correlated with EGRET Unidentified Sources" with Co-Investigators Glenn E. Allen and J. Keohane.

**Presentations at meetings**

AAS Meeting, Madison, June 1996, "EGRET Observations of Gamma-Ray Emission from Supernova Remnants," Esposito, J. A., Sreekumar, P., Hunter, S. D. Kanbach, G. 1995, BAAS, 188.28.06  
Extremes Workshop, NASA/GSFC, September 1996, "Observations of Gamma-Ray Emission from Supernova Remnants," Esposito, J. A., Sreekumar, P., Hunter, S. D. Kanbach, G.

## Publications

- "EGRET Observations of Radio Bright Supernova Remnants," Esposito, J. A., Hunter, S. D., Kanbach, G., Sreekumar, P., 1996, *ApJ*, 461, 820
- "Possible EGRET Gamma-Ray Burst Detection Independent of BATSE Triggering," Jones, B. B., Bertsch, D. L., Dingus, B. L., Esposito, J. A., Fichtel, C. E., Fierro, J. M., Hartman, R. C., Hunter, S. D., Kanbach, G., Kniffen, D. A., Lin, Y. C., Mayer-Hasselwander, H. A., Mattox, J. R., Michelson, P. F., von Montigny, C., Nolan, P. L., Pohl, M., Schneid, E. J., Sreekumar, P., Thompson, D. J., Tompkins, W. F., Willis, T. D. 1996, *ApJ*, 463, 565
- "Solar Modulation of Cosmic Electrons," Clem, J. M., Clements, D. P., Esposito, J. A., Evenson, P., Huber, D., L'Heureux, J., Meyer, P., Constantin, C., 1996, *ApJ*, 464, 507
- "EGRET Observations of the North Galactic Pole Region," Sreekumar, P., Bertsch, D. L., Dingus, B. L., Esposito, J. A., Fichtel, C. E., Fierro, J., Hartman, R. C., Hunter, S. D., Kanbach, G., Kniffen, D. A., Lin, Y. C., Mayer-Hasselwander, H. A., Mattox, J. R., Michelson, P. F., von Montigny, C., Mukherjee, R., Nolan, P. L., Schneid, E., Thompson, D. J., Willis, T. D. 1996, *ApJ* 464, 628
- "EGRET Observations of High-Energy Gamma Radiation from PSR B1706-44," Thompson, D. J., Bailes, M., Bertsch, D. L., Esposito, J. A., Fichtel, C. E., Harding, A. K., Hartman, R. C., Hunter, S. D., Manchester, R. N., Mattox, J. R., von Montigny, C., Mukherjee, R., Ramanamurthy, P. V., Sreekumar, P., Fierro, J. M., Lin, Y. C., Michelson, P. F., Nolan, P. L., Kanbach, G., Mayer-Hasselwander, H. A., Merck, M., Kniffen, D. A., Schneid, E. J., Kaspi, V. M., Johnston, S., Daugherty, J., Ruderman, M. 1996, *ApJ*, 465, 385
- "EGRET High-Energy Gamma-Ray Pulsar Studies. III. A Survey," Nel, H. I., Arzoumanian, Z., Bailes, M., Brazier, K. T. S., D'Amico, N., Esposito, J. A., Fichtel, C. E., Fierro, J. M., Hunter, S. D., Johnston, S., Kanbach, G., Kaspi, V. M., Kniffen, D. A., Lin, Y. C., Lyne, A. G., Manchester, R. N., Mattox, J. R., Mayer-Hasselwander, H. A., Merck, M., Michelson, P. F., Nice, D. J., Nolan, P. L., Ramanamurthy, P. V., Taylor, J. H., Thompson, D. J., Westbrook, C. 1996, *ApJ*, 465, 898
- "EGRET Observations of Gamma Rays from Point Sources with Galactic Latitude  $-30^\circ < b < -10^\circ$ ," Dingus, B. L., Bertsch, D. L., Digel, S. W., Esposito, J. A., Fichtel, C. E., Fierro, J. M., Hartman, R. C., Hunter, S. D., Kanbach, G., Kniffen, D. A., Lin, Y. C., Mattox, J. R., Mayer-Hasselwander, H. A., Michelson, P. F., von Montigny, C., Mukherjee, R., Nolan, P. L., Schneid, E., Sreekumar, P., Thompson, D. J., Willis, T. D. 1996, *ApJ*, 467, 589
- "EGRET Observations of the Region to the South of  $b = -30^\circ$  in Phase 1 and Phase 2 of the Compton Gamma Ray Observatory Viewing Program," Lin, Y. C., Bertsch, D. L., Dingus, B. L., Esposito, J. A., Fichtel, C. E., Fierro, J. M., Hartman, R. C., Hunter, S. D., Kanbach, G., Kniffen, D. A., Mattox, J. R., Mayer-Hasselwander, H. A., Michelson, P. F., von Montigny, C., Mukherjee, R., Nolan, P. L., Radecke, H. D., Schneid, E. J., Sreekumar, P., Shriver, S. K., Thompson, D. J., Willis, T. D. 1996, *ApJS*, 105, 331L

## Publications in preparation

- "In-flight Calibration and Analysis Refinements for the Energetic Gamma Ray Experiment Telescope (EGRET) on the Compton Gamma Ray Observatory" Esposito, J. A., Bertsch, D. L., Dingus, B. L., Fichtel, C. E., Hartman, R. C., Hunter, S. D., Kanbach, G., Kniffen, D. A., Lin, Y. C., Mayer-Hasselwander, H. A., L. M. McDonald, Michelson, P. F., von Montigny, C., Mukherjee, R., Nolan, P. L., Schneid, E. J., Sreekumar, P., Thompson, D. J., Willis, T. D. in preparation for *ApJS*
- "Observations of Gamma-Ray Emission from Supernova Remnants during EGRET Cycles 1-4" Esposito, J. A., Hunter, S. D., Kanbach, G., Sreekumar, P., in preparation for *ApJ*

Kai-Wing Chan

We have just started the production phase of the flight-quality ASTRO-E foils (on 28 October). The details of problems leading to the delay and the solution proposed was reported on the Annual Review in August and thus need not be repeated here. Briefly, there was a problem with the foil reflectors due to a mismatch of the thermal expansions between the aluminum substrate and the adhesive used to couple the substrate and the reflecting gold surface. The solution, accepted by the ASTRO-E Scientific Committee in June, is to reduce the thickness of the epoxy adhesive by about 40% and strengthen the substrate by using 156 micron aluminum instead of 127 micron aluminum.

Progress since then includes:

- (1) Adjusting for the replication with a thinner layer of epoxy, and testing such foils in the optical and x-ray, and their thermal response.
- (2) To arrange vendor to produce aluminum sheets with required quality, and test the samples. The first batch of material arrived earlier this month (October).
- (3) In addition, we have taken this opportunity to make some changes. We now use "nameplate" foils instead of mill-finished foils. This reduces the chances of "print-through" of epoxy, which will be more serious for the present case of a thinner epoxy layer. Such effect is confirmed both in the optical test and also in x-ray reflectometric test.
- (4) We have streamlined the production process to increase the production rate in order to catch up with the lost time. The current production rate is set at 18 reflectors a day, rather than the original 15, with a possibility that it will go to 21 reflectors a day once the production is shown to be satisfactory. The whole production and delivery will still be on schedule. A change of schedule---a delay---was already made in June for the delivery of the first quadrant of the first telescope. The whole project, as far as the mirrors are concerned, is expected to be on schedule.
- (5) We have successfully tested some replication process which further cuts down the thickness of epoxy by another factor of two. Even though many other details still need to be examined, the preliminary results, an x-ray reflectometric measurement included, is very encouraging (as of today). We probably will make a decision within two weeks or so as to whether we will implement this modification or not.

On the side of instrumentation, we have made the following installations.

- (1) We have set up an x-ray reflectometer which significantly speeds up many testing. Such tests used to be done by sending reflectors to Nagoya University, Japan. The new set up is mainly the contribution of Dr. Tarawa from Nagoya University, Japan, who visited us for six weeks during the summer; and Dr. Ogasaka, who is now with the mirror team.
- (2) We have also improved the optical testing by utilizing a large vertical monochromatic beam together with a CCD detector.
- (3) We also have installed an ultra-sound bath, with circulating propanol for cleaning the substrate. The system is on loan from the XTE group.

Besides these new developments in the group, I am also spending more time on the analytical aspects of the mirrors. In particular, I have developed a set of computer programs which allow us to study the effect of image degradation due to imperfect telescope or foil geometries (that is, alignment errors, imprecise reflector positioning, deviation of reflector shapes from perfect cones, etc.) Analytical image analysis---ray tracing---has mainly been handled by a group at Nagoya University and partly by Peter Serlemitsos of our group. At Nagoya, the imaging response of the

full telescope in x-ray is fully simulated, taking into account the response with detailed x-ray optics. However, such simulation consider little of the geometric defects which are more relevant to our process here (heat-forming/shaping of foils, matching of shape of replication glass mandrels, telescope tuning and alignment, etc.) Such processes can be investigated largely in geometrical optics, and that is the purpose of the present complementary study. The set of programs developed so far can handle change of foil thickness and variation in foil positions. They are still under continued development and I hope with the commencement of the full production of flight-reflectors, I will have more time to concentrate on the analytical studies.

Publications (also listed in the Annual Review):

Jiang, I.G., Chan, K.W. and Ko, C.M. 1996.

"Hydrodynamic Approach to Cosmic Ray Propagation. I. Non-linear Test Particle Picture", *Astron. Astrophys.* 307, 903-914.

Ko, C.M., Chan, K.W. and Webb, G.M. 1996.

"Cosmic Ray Modified Shocks with Injection in Hydrodynamic Approach. I. Injection Linear in Thermal Pressure", Accepted for publication in *Journal of Plasma Physics*.

This is to report the activities that have happened in the Astro-E mirror lab in the period of March to September, 1996. To fabricate five Astro-E mirrors and research on science and technologies are the two main responsibilities of Yang Soong who is working at GSFC with USRA employment.

1) The mirror fabrication. After a long period of trouble-shooting for the foil mirror thermal dependence since Feb. 96, we have come to a conclusion and a solution followed up in June 96. We have resumed the flight hardware production in Sep. 96, and the foil production is going to last for 2 years from now to fill up 5 telescopes of 7000 pieces of them in various radii.

2) To understand the error budget of the current configuration. We are in the process of clarifying the sources of the error which makes the image size, although was largely improved after the Astro-D project, still is about 4 times larger than the theoretical value. We will be trying different ways to reduce this error in terms of improvement in hardware and software, i.e. computer simulation.

3) The next X-ray spectroscopic imaging project is at the horizon. It is currently named as High Throughput X-ray spectroscopy (HTXS). It is planned to be operated in mid 2000. We are actively persuing the future participation.

4) A technique of multilayering of elements on thin foils intended to expand the energy band of the telescope up to 60 keV is under study in collaboration with the Gamma-ray group at GSFC and other international institutes. The goal is to make telescopes for balloon flight which aim at a higher energy observation in the next two years.

These were the main activities happened in the X-ray mirror lab in the last half a year period.

October 15, 1996

This is the last report of Greg Madejski's activity at USRA, and it includes the period until October 15th, 1996. As of October 16th, Dr. Greg Madejski will be working for the University of Maryland.

As usual, Greg's work consisted of a mixture of programmatic and research activities.

For the programmatic work, he is working on the Astro-E X-ray Spectrometer instrument. Specifically, he continued working on the problem of survivability of the blocking filters during launch conditions, and was involved in the low-temperature vibration testing of these filters. He also took part in the Science Working Group meeting for the Astro-E satellite in March, 1996 at ISAS in Japan.

For the research activities, he continued working on the high energy emission from both the radio-quiet Seyfert galaxies, and from blazars.

**The following papers appeared in press:**

- \* "3C279 Multiwavelength Monitoring: II. Ground-Based Campaign," P. Grandi, C. M. Urry, L. Maraschi, A. E. Wehrle, G. M. Madejski, M. F. Aller, H. D. Aller, C. D. Bailyn, T. J. Balonek, T. H. Bock, I. S. Glass, S. J. Lichfield, I. M. McHardy, J. S. Mulchaey, H. -P. Reuter, E. I. Robson, A. C. Sadun, W. Sherry, H. Steppe, J. A. Stevens, H. Terasranta, M. Tornikoski, and S. Wagner, *Astrophysical Journal*, 459, 73
- \* "Radiation Drag in Relativistic Jets," M. Sikora, H. Sol, M. C. Begelman, and G. M. Madejski, *Monthly Notices of the Royal Astronomical Society*, 280, 781
- \* 1996 "NGC 4945: The Brightest Seyfert 2 at 100 keV," C. Done, G. M. Madejski, and D. A. Smith, *Astrophysical Journal (Letters)*, 463, L63.

**He submitted the following papers:**

- \* "High Energy Emission in Blazars," G. Madejski, R. Hartman, T. Takahashi, F. Makino, H. Kubo, M. Tashiro, M. Sikora, I. McHardy, A. Wehrle, and W. Collmar, (Proceedings of conference "X-ray Imaging and Spectroscopy of Cosmic Hot Plasmas," Tokyo, Japan) (in press)
- \* "Asca Observation of X-ray/TeV Flare from the BL Lac Object Mkn 421," T. Takahashi, M. Tashiro, G. Madejski, H. Kubo, T. Kamae, J. Kataoka, T. Kii, F. Makino, K. Makishima, and N. Yamasaki (*Astrophysical Journal (Letters)*) (in press)
- \* "Variability in the Inverse-Compton X-ray Flux from the Jet in Quasar 3C345," S. Unwin, A. Wehrle, A. Lobanow, J. Zensus, G. Madejski, M. Aller, and H. Aller (*Astrophysical Journal*) (in press)
- \* "X-ray Spectra of Broad-Line Radio Galaxies," P. Wozniak, A. Zdziarski, D. Smith, G. Madejski, and W. Johnson (*Monthly Notices of Royal Astronomical Society*) (submitted)

Greg Madejski's USRA Report - Oct. 15, 1996



- \* "On the Applicability of Emission Models of Gamma-ray Blazars," M. Sikora, G. Madejski, R. Moderski, and J. Poutanen (Astrophysical Journal) (in press)
- \* "An X-ray Absorption Feature in the BL Lac Object H1426+428", R. Sambruna, I.M. George, G. Madejski, C.M. Urry, T.J. Turner, K.A. Weaver, L. Maraschi, and A. Treves (Astrophysical Journal) (submitted)
- \* "Multiwavelength Monitoring of the BL Lacertae Object PKS 2155-304 in May 1994. I. Probing the Inner Jet through Multiwavelength Correlations," C. M. Urry, A. Treves, L. Maraschi, H. Marshall, T. Kii, G. Madejski, P. Smith, E. Pian, R. Fujimoto, F. Makino, C. Otani, S. Penton, J. E. Pesce, R. Sambruna, K. Sasaki, J. M. Shull, T. Takahashi, and M. Tashiro (Astrophysical Journal) (submitted)

**He delivered two invited talks:**

- \* "High Energy Emission from BL Lacs," invited talk at the conference "X-ray Imaging and Spectroscopy of Cosmic Hot Plasmas," Tokyo, March 11-14, 1996.
- \* "X-ray Spectrum of Seyfert 2 Galaxy NGC 4945," invited talk at the conference "X-rays and gamma-rays from accreting black holes," Koninki, Poland, June 11 - 14, 1996.

**Major work in progress:**

- Supervision of Ph.D. thesis work of Mr. Charles Hall of Catholic University: the first thesis paper, "On properties of the scattering medium in Seyfert galaxies in the context of the Unified Models" should be submitted by the end of October 1996.
- Co-supervision of Ph.D. thesis work of Mr. Hidetoshi Kubo of Tokyo University and ISAS (with Prof. Tadayuki Takahashi). The subject is "X-ray Observations of GeV-emitting Blazars."

**Service work:**

- Dr. Madejski participated in the CGRO Peer Review, and will participate in the HST Peer Review (end of October 1996).
- Dr. Madejski delivered a public outreach lectures at the National Youth Science Camp in Bartow, West Virginia, in July 1996.
- Dr. Madejski lectured at the Evergreen State College (Olympia, WA) on "Origin of chemical elements" on October 2, 1996.

**Proposals accepted:**

PI for one, and a major Co-I for another CGRO proposal; PI for two and major Co-I for one XTE proposal; PI for one ROSAT proposal.

## **Final Technical Report, Michael Loewenstein, 4/1/96-9/4/96**

“Measurement of the Elemental Abundances in Four Clusters of Galaxies I. Observations,” (R. F. Mushotzky, M. Loewenstein, K.A. Arnaud, T. Tamura, Y. Fukazawa, K. Matsushita, and I. Hatsukade) and “Measurement of the Elemental Abundances in Four Rich Clusters of Galaxies II. The Initial Mass Function and Mass Loss in Elliptical Galaxies, Enrichment and Energetics in the ICM,” (M. Loewenstein and R. F. Mushotzky) appeared in the August 1 issue of the ApJ (466, 686 and 695).

“The Consistency of Fe Abundances from L and K Emission in Clusters of Galaxies” by U. Hwang, R. F. Mushotzky, M. Loewenstein, T. H. Markert, Y. Fukazawa, and H. Matsumoto – has been accepted for publication by the ApJ; final revisions are in progress.

“The Mass of Abell 1060 and AWM 7 from Spatially Resolved X-ray Spectroscopy: Variations in Baryon Fraction” by M. Loewenstein and R. F. Mushotzky has been accepted for publication in ApJ Letters.

“X-ray Properties of Early Type Galaxies as Observed with ASCA” by H. Matsumoto, H. Awaki, M. Loewenstein, et al. is nearly complete and will shortly be submitted to Publications of the Astronomical Society of Japan.

I gave talks on the cosmological implications of our work on clusters of galaxies for the Goddard cosmology seminar on April 24, and for the Center for Astrophysical Sciences weekly seminar at Johns Hopkins University on April 16.

Evidence from ASCA of X-ray counterparts to HST-discovered micro-quasars was presented at the HEAD meeting in San Diego in May. I also contributed to Nick White’s HTXS presentation at that meeting.

I gave a two hour April 1 seminar on “Investigating Dark Matter in the Universe with X-ray Observations” for the “Current Perspectives in High Energy Astrophysics” course offered by the University of Maryland Astronomy Department, and am preparing a written version for inclusion in an upcoming NASA LHEA Reference Publication.

I gave the invited talk on “Cooling Flows in Elliptical Galaxies” at the international Cooling Flows in Galaxies and Clusters Conference in Oranim, Israel in July.

This report describes project work completed during the above time frame, as well as papers submitted, talks given and meetings attended.

MOXE-related items:

MOXE project work:

- April 1        The MOXE instruments underwent a week of EMI testing at Goddard; MOXE successfully passed the EMI tests.
- April 13       One of our Russian collaborators from IKI, Vadim Arefiev, arrived at Goddard for a 10 week working visit. During his stay we worked on development and testing of the MOXE Quick Look Analysis (QLA) facility. This is a set of programs written in C and IDL which read various MOXE data formats and display instrument housekeeping and scientific data in graphical format. Vadim returned to IKI on June 28.
- April 22-25    The GSFC MOXE team hosted a three day Flight Software meeting, which took place at the USRA off site office. Participants from Los Alamos National Lab attended, as did two IKI scientists. This meeting helped the team to kick off a busy summer for the MOXE instrument, and we appreciate the time and cooperation of the USRA staff in making the meeting possible, on short notice.
- June 24-27    The MOXE Pre-ship review was held at Goddard. I prepared a presentation of some results of calibration data that I analyzed earlier in the year. The pre-ship review was very favorable for the MOXE instrument.
- Aug 20 and following---I was involved in the preparations for the Flight Acceptance test for MOXE and XRS, the other US instrument to be flown on Spectrum X-Gamma. The preparations included coordinating the computer needs of the various teams involved in the test, some set up of the test facility in Building 20, getting the computers at the facility hooked up to the Internet, and many other last minute tasks. In addition we finalized a draft version of the QLA code to be run during the test.
- Sept 5-27-    The MOXE/XRS Flight Acceptance Test took place. Members of the spacecraft team, the data sharing instrument team, and the two scientific instrument teams designed and ran numerous scenarios of observation modes to test all of the pipeline for data, from the moment it is detected by the instruments through to its display at the QLA facility. We encountered a few surprises along the way about the flight software, but by the end of the test MOXE was communicating as expected with the spacecraft. MOXE has thus been accepted for flight on Spectrum X-gamma.

## Other science activities:

Papers published: During this period, the following papers were published based on my prior and continuing work with HSP data:

Michalitsianos, A.G., Dolan, J. F., Kasanas, D., Bruhweiler, F. C., Boyd, P. T., et al, "Lyman-alpha absorption-line systems in the gravitational lens Q0957+561", ApJ, V474, (to appear Jan 10, 1997)

Dolan, J. F., Boyd, P. T., Nelson, M. J., Percival, J.W, et al., "Hubble Space Telescope Observations of AGNs in the Ultraviolet: BL Lac and Q2345+007", (to appear in Astrophysics and Space Science, 1997)

Graham-Smith, F. Dolan, J.F., Boyd, P.T., Biggs, J. D., Lyne, A. G. And Percival, J. W., "The ultraviolet polarization of the Crab pulsar", Mon. Not. R. Astron. Soc., 282, 1354-1358 (1996).

In preparation:

Dolan, Hill, Boyd, Silvis, Robinson et al., "Reprocessed UV pulses from the companions of X-ray binary stars", in preparation for ApJ or ApJ letters

## Science Community Service:

May 1-3 I traveled to Indianapolis, IN to attend the APS/AAPT meeting. I was inaugurated as the new Secretary/Treasurer of the Division of Astrophysics, a position I will hold for the next two years.

Aug 25-28 I served as an XTE proposal reviewer at Tysons Corner Virginia.

## Education and Public Outreach

May 23 Arkansas University student Rekha Pradhan arrived at GSFC for a second summer to carry out research with me. This year we concentrated on the initial value space of the gravitational three body problem, and Rekha discovered some surprising structures present when the three stars have unequal masses. Rekha returned to Arkansas on August 15th.

July 16 The teacher intern program AAstra brought a number of elementary through high school teachers to Goddard. I participated in a break-out session where a number of teachers and I had a round table discussion about how I became an astronomer, my interests in school as a child, and ways to motivate girls in math and science. Some of our discussions have given us ideas about how to present the astronomers on the High Energy Astrophysics Learning Center.

Aug 2 I traveled to Drexel University in Philadelphia, where I served on the PhD thesis defense committee of Janet Houser. Her thesis was on the numerical simulation of gravitational waves from rotating collapsing compact objects. Janet was awarded her PhD.

Sept I worked with Gwynn Park High School physics teacher and physicist Heide Doss on preparing a proposal for the IDEA grant program to help communicate the method of measuring the mass of a neutron star to high school students.

#### Proposals Submitted

July 1 I was the P. I on a proposal submitted to the XTE program to observed Vela XR-1 simultaneously in the X-ray and UV/optical. My co-investigators are HSP team members, as the project builds on early HSP results, and a high school teacher to help communicate the methods used by astronomers to the high school audience. The proposal was successful, and has been awarded time to be coordinated with HST time and observations at Las Campanas observatory.

Sept. 13 I was a co-Investigator on an HST proposal to observe Vela XR-1 simultaneously with XTE and STIS. This is tied with the XTE program described above.

## TECHNICAL REPORT

(1 April 1996 - 30 September 1996)

Name: Paul Barrett  
Activity: 5030-20A-39

### I. SUMMARY

#### A. Task Work

##### 1. COSSC Bibliography

Work on the COSSC bibliography has occurred at a much lower priority, since it was discussed in the previous technical report. All that remains to be done to bring it up-to-date is the years 1991 and 1992. Dora Sermlemitos is assisting me with this task.

##### 2. COMPASS (COMPtel Analysis Software System)

Most of my effort during this period was directed at assisting COMPTEL guest investigators analyze their data at Goddard. And some effort has gone into maintaining COMPASS.

The EGRET DRI data was obtained from the COMPTEL team and integrated into COMPASS.

Work has begun on updating the COMPTEL web pages. The first project being the creation of a COMPTEL source list, so guest investigators can see if the source that they are interested in has been observed and analyzed. This should help the GI during the next proposal submission process.

Other proposed COMPASS projects are to create an automated 'pipeline' for archiving the COMPTEL data in FITS format and to move the COMPASS software from the node 'cosmic.gsfc.nasa.gov' to 'compass.gsfc.nasa.gov' and to upgrade the two nodes with a new operating system and an additional processor. Initiation of this project has been delayed until the system managers at Univ of New Hampshire acquire more experience about the upgrade.

##### 3. Remote Proposal Submission (RPS)

At the beginning of this report period, much attention was given to helping guest observers submit their CGRO Cycle 6 proposals. Now that the system is more stable and most of the GO are familiar with the system, less effort was required to support GO during this cycle.

I continued to attend the bi-weekly RPS meetings during this period and some work was done preparing for CGRO Cycle 7.

##### 4. Argus (was Multi-mission Interactive Proposal System, MIPS)

As noted in the previous report, most of the effort for this project was spent at meetings to discuss the design and implementation of a Web version of this software. I prepared and delivered the cycle 5 Timeline to the database programmers. This meeting has been integrated into the database meetings, so I have stopped attending after delivering the information requested of me.

## **B. Research**

### **1. Soft X-Ray Survey of CVs Using Archival ROSAT data.**

Some effort has been periodically spent on this project coordinating follow-up ground-base optical observations with collaborators. Efforts will continue until most of the sources in the Ultra-Soft Source list has been identified. A paper on some white dwarfs discovered during the survey is in preparation.

As part of this research, I have volunteered my services as a mentor for a senior research project. This project began in mid-September and will last throughout the school year.

### **2. Compton/COMPTEL Data**

Some additional progress has been made on analyzing the CompTel data. Work as has been slowed due to programmatic activities and other scientific research projects.

### **3. XTE Proposal.**

Much work during March and August 1996 was spent scheduling simultaneous ground-based observations of our 2 XTE sources in the proposal "X-Ray Oscillations in AM Her Binaries". This time was obtained and the observations have been made. Work on analyzing this data will begin soon. The death of one of the Co-Is has required some changes in carrying out this project.

### **4. McDonald Observatory Proposal**

I was Co-I on a proposal submitted to the McDonald Observatory in Texas to make simultaneous optical and XTE observations of the magnetic Cataclysmic Variable EF Eri in 1996 October. This proposal was accepted.

### **5. Identification of 6 White Dwarfs in the ROSAT archive.**

A poster was presented at the High Energy Astrophysics Division Meeting in San Diego about the identification of 6 new white dwarfs using archival ROSAT data. A paper is in preparation.

### **6. Electronic Proposal Submission (EPS) software**

Some progress was made on a prototype for Electronic Proposal Submission software. This project is designed to replace the current RPS software with a simpler and more robust design for both programmers and users. Work on this project has slowed.

### **7. ISO proposal**

I was Co-I on a ISO proposal submitted in mid-September. This is a resubmission of a previous ISO proposal.

### **8. J1802 paper and NGC 55 paper**

A paper about IUE observations of the binary star J1802-1804 was submitted to ApJ. Another paper about archival ROSAT observations of NGC 55 was also submitted. I was a co-author on both papers.

## **9. CGRO Cycle 6 Proposal**

I assisted in the preparation of a CGRO Cycle 6 Proposal. Eric Schlegel is PI and Chris Shrader, Daryl Macomb, and I are co-Is. This proposal was accepted.

## **II. FUTURE WORK AND RESEARCH**

### **A. Task Work**

#### **1. Compton GRO Publication Database**

Continue enhancing the GRO publication database by adding new publications.

#### **2. COMPASS Software Administration**

Work will continue on administration, maintenance, and improvements to the COMPASS software here at Goddard. Will work on proposal to upgrade software and hardware of both Sun SPARCstation 20s. Enhancing the COMPASS web pages and assisting guest investigators.

#### **3. RPS Meetings.**

Attendance at RPS meetings will continue in anticipation of the next CGRO proposal cycle.

### **B. Research**

1. Continue working on ROSAT Survey of Cataclysmic Variables.

2. Continue working on COMPTEL data analysis.

3. Continue analysis of XTE data of 2 cataclysmic variables.

4. Continue working on identification of ROSAT Ultra-soft Sources.

## **III. MEETINGS AND SYMPOSIA ATTENDED**

1. Attended the High Energy Astrophysics Division meeting in San Diego, CA during 1996 May 1-4.

2. Attended the Astronomical Data Analysis and Software Systems (ADASS) VI Meeting in Charlottesville, VA in 1996 September 23-35. I sponsored a Bird-of-Feather session. A summary of the session will be written up in the proceedings.



Dr. Daryl Macomb  
Technical Report

My support work consisted of the following: Continued to act as the EGRET support person at the CGRO Science Support Center. This has involved supplying GI's with software and data, keeping them informed of timeline changes, and working on documentation. I have been working on a new EGRET CD to be distributed next spring which will encompass all current EGRET archival data, software, and documentation. Extensive work on HTML/JAVA access to this CD is a major portion of this effort. In addition, I have continued to take part in efforts to provide public outreach for gamma-ray astronomy through devoting considerable effort to a "New Windows" brochure describing the science associated with the SEUS program and through some beginning efforts at publishing the work of NASA's Gamma-Ray Astronomy Working Group. I have also continued to work on other WWW related issues.

In terms of research, I have made progress on three programs involving a general gamma-ray catalog, an analysis of gamma-ray sources above 1 GeV, and studies of the pulsar PSR 1509-58. I anticipate papers on all three topics being submitted by early spring. I have also spent some time looking into options for flying the proposed GLAST experiment on the shuttle as part of the GAS or Hitchhiker program.

**Bi-Annual Progress Report for  
Chris R. Shrader, USRA/CGRO-SSC  
(Activities for April 1, 1996 - November 1, 1996)**

**CGRO Guest Investigator Program:** The Cycle-6 peer review was organized with the cognizant Project and Program Scientists. The review was held during June 1996. 230 proposals were reviewed by 5 scientific review panels. A separate process was devised to review budget requests for accepted proposals independent of the initial scientific peer review. My contribution was to organize and chair the review, and oversee the database compilation of the results.

Extensive database preparation efforts were conducted prior to the development of the Cycle-6 Viewing Plan. The time-line committee met during July to construct the detailed time-line. Guest Investigators were notified of the outcome of their proposals shortly thereafter.

The CGRO Cycle-7 NRA and appendices were edited, and will shortly be presented in draft form to the Program and Project Scientists. Some significant changes to the program, including the modified use of the EGRET instrument, and some new policy issues such as the proprietary data-rights period and PI Team funding guidelines required major changes to certain portions of the NRA.

Routine Guest Investigator inquiries, too numerous to list, were handled. Subjects included instrumentation technical details, program policies and procedures and the proposal evaluation process.

Several presentations were made to the CGRO Users Committee regarding the Cycle-6 peer-review and budget review processes and the Cycle-7 NRA.

**Project Support:** The technical section of the CGRO proposal to the NASA HQ Senior Review Committee was drafted and distributed to the CGRO Users Committee for feedback. A finalized version of the proposal was delivered to the project scientist. Real-time support to the project scientist was provided during the Senior Review Oral defense.

Various statistics regarding the CGRO Guest Investigator program were supplied upon request to NASA Headquarters and the Project Scientist. Supervision of the SSC GI Program database continued.

Participation, as co-chair, on the local organizing committee for the Fourth Compton Symposium was continued during the reporting period. A draft "Second-Announcement" was prepared in collaboration with the CGRO scientists at the Naval Research Laboratory, which will host the symposium in April of 1997.

**CGRO-SSC Group Leader Activities:** Various internal CGRO-SSC organizational meetings were held to coordinate the various ongoing activities.

Planning to offset the impact of forthcoming staffing changes, including the probable departure of the COMTEL and BATSE Instrument Specialists, at the CGRO-SSC are ongoing. A job candidate search and review was conducted along with USRA management.

**Scientific Research:** Three articles were submitted to scientific journals for publication (one as first author, 2 as co-author). Topics included X-ray Nova, Be X-ray Transients and Cataclysmic Variables. An additional article on X-ray nova is nearly ready for submission.

An invitation to prepare a review article on Blazar QSOs was received from the Fourth Compton Symposium Scientific Organizing Committee.



# REPORT DOCUMENTATION PAGE

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